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The Costs of Living with Elephants in Namibia

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Introduction

When people in the West think of elephants, they tend to think of the benefits of this magnificent species. Those benefits include the viewing value for those fortunate enough to travel to elephant range states to see them, or even the substantial existence value placed on the elephant by those who will probably never have the opportunity to view them in the wild. Of course, there is also the potential to derive benefits from elephants in the form of trophy hunting revenues and elephant products such as ivory, hide, and meat. However recently, due in large part to pressure from western conservation organizations, these potential benefits have been downplayed.

What many people in countries without wild elephant populations fail to realize is that there are also substantial costs to living with elephants. For example, a farmer can lose his entire annual crop to a herd of elephants in a single night. There are also more indirect costs that result from elephants tying up scarce resources which could otherwise be used for other productive activities.

While the benefits of maintaining large elephant populations in the wild are often expounded by conservation organizations, western governments, and donor agencies, the costs to the elephant range states of hosting these populations is often unknown or ignored. In addition, traditional models of renewable resource management developed by economists (e.g. Clark) and biologists (e.g. Schaefer) were primarily intended for use in analyzing marine fisheries, and do not take into account the possibility of stock-related costs. These circumstances have led to policies that ignore the costs of living with elephants. The result is that farmers in areas like the Caprivi Region of Namibia often feel a great deal of animosity toward elephants and the government ministries and non-governmental organizations that are trying to conserve them.

This attitude has the potential to hamper future conservation efforts. In addition, the lack of attention to costs can lead to economically inefficient management policies that do not allow elephant range states to derive the maximum net benefits from their elephant stocks.

The purpose of this paper is to describe the nature of the costs of living with elephants, to discuss possible ways to measure these costs, and to outline implications for elephant management policy.

The Nature of Costs

The costs of living with elephants can be divided into several categories. There are damage costs, other direct costs, indirect costs, and environmental costs. Damage costs include the destruction of crops, property, and human life by elephants. Direct costs include expenditures on deterrents to elephant damage and expenditures on management services required by the elephant population. Indirect costs include the opportunity cost of base resources required to sustain a healthy elephant population, such as land and water. Other indirect costs are associated with changes to agricultural production systems in order to avoid elephant damage. Further, it is likely that farmers who are victims of frequent elephant attacks suffer from psychological stress as a result. Finally, in some parts of Africa the elephant appears to be locally overpopulated. This can result in considerable damage to the ecosystem, which also entails costs.

It should also be noted that the costs of living with elephants can be borne by different sectors of society in African range states. For example, damage to crops will most directly affect farmers living in areas adjacent to elephant habitat. However, it is also possible, under certain market conditions, for consumers in the elephant range state to bear part of the costs of elephant damage in the form of higher prices paid for the food that they consume. On the other hand,

costs associated with management services are borne by the wildlife management ministry of the host country.

There are also spatial issues that affect costs. The costs of elephants are related to the closeness of their contact with humans. Thus, if game parks are long and thin or fragmented, and located adjacent to agricultural areas, the amount of damage (direct and indirect) will be great compared to a park that is square or circular, large, and as far away from agriculture as possible. It is crucial to understand the spatial relationships between parks and the damage that protected elephant populations cause in order to decide which areas ought in fact to be used as parks and how to manage the parks (e.g. fence them off if the damage is unacceptable).

To illustrate the forms in which these various costs can occur, it is useful to appeal to a particular case. Thus, the situation in Namibia in southwestern Africa will be explored, with particular emphasis on the Caprivi Region. The Caprivi Region is blessed with an abundance and diversity of wildlife, and is one of the few places in the country where significant numbers of wildlife roam freely outside the confines of parks or game ranches. However, the region is also home to a rapidly growing human population that primarily exploits natural resources to fulfill its needs for economic development. Of late, drought and a veterinary fence along the Botswana border have put increasing pressure both on wildlife populations and on the agricultural system. The combination of these factors has resulted in substantial conflict between Caprivian farmers and the local wildlife. The Caprivi is a relatively small area and is home to approximately 5,000 of Namibia's 12,000 elephants and borders on areas of Botswana and Zimbabwe with large elephant populations.

Damage costs in Caprivi include substantial and frequent crop damage, particularly in those areas in eastern Caprivi which border on Botswana. Problem animal reports completed by

community game guards in the area show that elephants are by far the most common reason for wildlife damage claims, accounting for 38% of total claims and 55% of herbivore claims in 1996/1997 (von Rohr). In recent meetings with game guards and farmers in the eastern Caprivi, they claimed that in some years all farmers in certain villages suffer substantial crop losses due to elephants. While this may be an exaggeration, the farmers were clearly upset and concerned about the damages that they incur from elephants. They pointed to elephants as being by far their biggest problem animal, and were very frustrated by their inability to avoid elephant damage and by a perceived lack of assistance from the authorities. There have also been recent reports of people being trampled to death by elephants in Caprivi, and in general people are very fearful of the elephants.

In other areas of Namibia, elephant damage takes on different forms. For example, in the northwest of the country there is little cultivation of crops because of the prohibitively dry climate. However, there is extensive livestock herding. In order to provide water for domestic stock, it is often necessary to drill bore holes and construct water distribution infrastructure. There have been reports from this area of elephants destroying these structures in the search for water. They also cause damage to fences, sometimes resulting in livestock escaping, and they have even been known to topple houses.

In order to avoid or reduce damage from elephants, farmers try various strategies to deter them. Especially during the harvest season, farmers expend a great deal of labor attempting to guard their fields from elephants. Different methods, such as lighting fires, beating drums, and even firing guns into the air are tried. However, farmers explain that elephants, with their great intelligence, quickly learn that they will not be harmed by these methods and often return to eat the crops. More modern methods, such as electric fencing and trip alarms have also been tested.

Despite the high cost of these deterrents, elephants have learned to foil them as well. Another method that has apparently been used with some success in Zimbabwe is the firing of tear gas canisters filled with chili pepper. But so far, no method has been able to completely deter the elephant. It should be noted that elephants do not destroy crops solely by eating them, but can also cause considerable damage by trampling crops while in transit.

Living with elephants also requires expenditures on management services. In Caprivi, community game guards are employed in areas with wildlife resources in order to monitor wildlife-human interactions locally and to report any problems. These game guards are currently paid by conservation groups, but are supposed to eventually be funded by proceeds from community conservancies. In addition, the Ministry of Environment and Tourism (MET) employs rangers who are also supposed to respond to problem animal reports as well as enforce anti-poaching laws. The MET also employs research and policy staff to help create management strategies.

Potentially, one of the biggest costs to elephant range states of having elephants within their borders is the opportunity cost of elephant habitat. In general, elephants and agriculture are incompatible. While elephants will often travel into farmlands in search of food and water, they require a certain amount of space to be set aside for them as core habitat. Since elephants are a keystone species in their ecosystem, the area of park space required is often directly linked to the size of the elephant population. Once this land is set aside for wildlife, it cannot be used for other economically productive purposes such as agriculture, industry, or housing. As a result, there are economically important costs associated with this loss of opportunity. In the relatively small Caprivi Region, there are currently three national parks (Mahango, Mamili, and Mudumu), as well as the extensive West Caprivi Game Park. In all cases (with the possible exception of the

West Caprivi), the creation of these parklands required the relocation of communities and/or the conversion of agricultural land.

Other indirect costs are associated with changes in agricultural practices forced by living with elephants. For example, in Caprivi this can mean avoiding cultivation along rivers where soils are rich and water is plentiful because elephants also favor these habitats. It can also mean shifting production from a profitable crop that is favored by elephants to a less profitable crop that elephants are less likely to attack. For example, elephants seem to be particularly partial to melons and vegetable crops. These also tend to be relatively high-value crops in the farmer's portfolio. Elephants might also affect agricultural practices seasonally. For example, farmers might avoid producing intensive, dry-season gardens because other food is scarce at this time so the gardens would be particularly attractive to elephants.

From discussions held with farmers in the Caprivi, it seems that they are often traumatized by their encounters with elephants. In areas where elephant attacks are common, it appears that farmers and their families endure substantial psychological stress from spending long nights in the fields chasing away elephants and worrying about their crops. It is possible that other species, such as birds and rodents, cause even more damage to crops than elephants. However, because of its awesome presence, the elephant is more terrifying to farmers, which probably explains its identification as the most frequent problem animal. Farmers also report that their children are prevented from attending school at certain times of the year for fear of being attacked by elephants. To the extent that this psychological stress reduces the wellbeing or utility of farmers, it should be considered a cost of living with elephants.

Elephants are a keystone species, and are sometimes called the "engineers of the jungle" because of the tremendous impact they have on their environment. They create roads through

the bush, dig water holes, and consume massive amounts of food and water. It is likely that having either too few or too many elephants in an area can have a detrimental effect on an ecosystem. In some places, such as the parks of Caprivi, it is possible that there are too many elephants. For example, elephants used to inhabit parks such as Mahango on the Okavango River only during the dry season. However, it has recently been observed that a percentage of the park's growing elephant population now remains in the park during the entire year. The reasons are unclear, but may be the result of the loss of traditional migration paths due to increased human development, war in Angola, and a veterinary fence along the Namibia/Botswana boarder. The result has been irreversible damage to the fragile riverine habitat, with few large trees left standing. This has economic implications to the extent that these habitats are unique and support specialized animal and plant species (e.g. the lechwe) which also have value. In addition, the elephant-damaged ecosystem might be less appealing to tourists so that tourism revenue is reduced.

Measurement of Costs

One of the challenges of incorporating the costs of living with elephants into management models is the difficulty of measuring the costs. In particular, the task of measuring damages from elephants seems daunting. One might imagine simply going to farmers and asking them what damages they have incurred over the past season. However, those farmers may not keep accurate records of the damage, and the results would be viewed with suspicion anyway as farmers have an incentive to overestimate the damage costs in an effort to increase the aid that they receive. There are several methods which may be employed to overcome this problem, including physical measurement, production/profit function estimation, and hypothetical methods. In addition to the relative strengths and weaknesses of each method, one

must also consider the availability of secondary data that can be exploited for the study area. In any event, it is crucial to have accurate measures of costs in order to create realistic models of elephant management in Africa.

The direct, physical measurement of damages which has been employed by some biologists involves having someone on the ground at the place and time of the attack in order to estimate the extent of the damage to crops or structures (e.g. O'Connell). Then, some sort of accounting value is placed on the damaged goods in order to aggregate and compare damages. One advantage of this method is that the researcher does not have to rely on the word of the farmer to acquire the information. However, there are also several disadvantages. First of all, assuming that the physical extent of the damage can be accurately measured, how does one assign accurate values to the damage? The value of crops depends on divining what the harvest would have been without the attack (but, what if there was a drought after the attack anyway?), where and when the crops are sold, the quality of the produce, etc. Second, for most researchers the logistics and cost of stationing agents in each area where attacks may take place are prohibitive. Third, and perhaps most importantly, the direct measurement of damages overlooks all of the indirect costs of living with elephants that were outlined above. It is possible that these costs, such as the opportunity cost of growing less valuable crops because elephants are less likely to damage them or the cost of psychological stress, may be more substantial than the direct costs.

Another possibility for measuring damage costs is the econometric estimation of production or profit functions. The farmer's production function is a mathematical function that relates the maximum amount of a good that can be produced to alternative combinations of inputs. Inputs can be variable, such as labor or fertilizer, or fixed such as machinery or irrigation

infrastructure. In elephant range areas, elephant-related inputs could also be included. For example, a variable input to crop production could be the amount of labor expended guarding fields from elephants. A fixed input could be the existence of an electric fence to deter elephants. In addition, attributes such as rainfall and soil quality can be included to control for environmental factors. In elephant range areas, another environmental factor could be the size of the local elephant herd. These physical attributes would also be considered fixed factors of production (at least for one growing season). By collecting data from a range of farmers in a diversity of areas, including those with and without elephants, the effect of the local elephant population on agricultural production can be determined.

Unfortunately, the estimation of multi-product production functions is notoriously difficult. For multi-product producers (such as most small-scale farmers), there is no simple way to aggregate production. Besides, we are after economic values and not physical quantities of production. A more workable alternative is the estimation of profit functions. Economic duality theory ensures that for every production function, there is a corresponding profit function. This makes aggregation of outputs easier because the units are monetary values. Furthermore, a profit function can be used to directly determine farmers' losses in profits and the adjustment of the crop mix and input use due to changes in the elephant stock. It can also be used to compute the effect of deterrents on profitability. One disadvantage of this method is that very detailed agricultural production data, preferably time series, is still required. However, unlike park services, agriculture ministries in many countries do collect micro-level data via household farm surveys for use in agricultural planning. Another disadvantage is that the cost of the psychological stress from living with elephants is not measured. So far, there is no evidence in

the literature of this method being used to value the cost of living with elephants or other wildlife.

The final approach involves hypothetical methods. These methods derive data for analysis of costs based on responses to questions of the form, What would you do if...? or Would you pay...? (see Freeman). Hypothetical methods are used to value things which are not marketed, or which cannot be linked to observed choices of marketed goods. The most commonly used hypothetical approach involves asking people what value they place on a specific change in an environmental amenity, such as the number of elephants, given constraints such as income. The responses are direct expressions of the value placed by people on the amenity. The term contingent valuation method (CVM) is typically used to describe approaches based on this type of question. The survey usually begins by clearly describing what the current situation is. Then, values are elicited from the respondents for hypothetical changes in the situation. For the case of elephants in the Caprivi, for example, the survey could describe the number of elephants currently encountered by farmers in the area. Then, hypothetical deterrent schemes could be described which lower the incidence of encounters by various amounts. For example, an electric fence might lower the incursion of elephants into farmers' fields by 30%. The farmer would then be asked to place a value on the fence. This would indicate how much the farmer values a reduction in the number of elephants by 30%. The farmer could also be asked to value deterrents that lower the number of elephants by other amounts. Assuming that the farmer has good information about what his production and marketing possibilities are, the responses will also incorporate opportunity values as well as the value of reduced psychological stress. One problem with this method is the validity and reliability of the data. That is, it is always possible to give hypothetical answers if the respondent knows that the questions are

hypothetical. Another problem is that small-scale farmers might not have any money to spend on deterrents, and so zero responses might be common. However, it may be possible to get around this by asking farmers, for example, how much labor or how many sacks of grain they would be willing to contribute to a fence-building project. Further, it is still necessary to obtain data on agricultural inputs and outputs if costs from changes in production strategies are to be accounted for.

The specific method chosen to measure costs should take into account the type and quality of secondary data available for the study site. For the Caprivi Region of Namibia, there are efforts underway to collect the necessary data for effective resource management. Unfortunately, most of these projects began after independence in 1990, so long time series are not available. One data collection effort, sponsored by a local conservation group (IRDNC), involves the use of community game guards to complete problem animal reports when attacks by wildlife occur. These reports contain information such as the time and location of the attack, and attempt to estimate physical damage (which is more difficult for herbivores than for predators). This is an ongoing process that began in 1991. Another effort is the Environmental Profiles project undertaken by researchers of the Directorate of Environmental Affairs, MET (Mendelsohn and Roberts, 1997). This project collected extensive physical data for Caprivi on variables such as wildlife populations, rainfall, soil quality, vegetation, bush fires, and distance to rivers, and organized it in a GIS format. Unfortunately, this data is only available for the base year of 1997. Another effort, this time by the Ministry of Agriculture, Water, and Rural Development, involved completing detailed household farm management surveys in Caprivi. Survey enumerators lived in the subject villages for a period of eight months and returned to the same household on a bi-weekly basis. Questions were asked on all aspects of agricultural

production, including input use, production, and purchases and sales. In total, 150 households were surveyed in six villages in different parts of eastern Caprivi. Unfortunately, this data is also only available for 1997, and no specific questions were asked about wildlife damage or the use of deterrents. No known efforts have been made to collect data on deterrent use, econometrically estimate production or profit functions, or conduct CVM surveys as described above.

Policy Implications

To date, the costs to African range states of living with elephants and other wildlife have mostly been ignored. This has several negative consequences. First of all, it can result in economically inefficient wildlife management. By failing to take into account the negative externalities¹ generated by elephants on the people who share their habitat, decision-makers will tend to promote sub-optimally large elephant populations and allocate land to elephant habitat sub-optimally (in area, shape, and location). One result of this is the frustration and animosity toward elephants currently expressed by rural inhabitants of the Caprivi Region of Namibia. In the long run, considering the democratic system of government currently in place, this could have negative impacts on conservation efforts if citizens demand that wildlife be displaced. There are several possible ways in which a more economically efficient solution could be achieved. For example, farmers' activities could be modified, farmers could be paid compensation for damages, the rural population could be provided with the means of generating positive externalities from local wildlife (e.g. the establishment of conservancies), park lands could be consolidated, or the elephant population could be reduced.

¹ *Externalities*: when the activities of one economic agent affect the activities of another agent in ways that are not taken into account by market forces.

One of the problems with determining the optimal size of the elephant population and habitat is that traditional models of renewable resource management have not been capable of incorporating land allocation decisions or non-harvest related stock externalities. In particular, the traditional models, developed for use in marine fisheries, do not allow for negative externalities such as crop damage. This may in part be the reason why these issues were ignored in previous efforts to model elephant management (see Milner-Gulland and Leader-Williams). However, recently economists have been making attempts to improve their renewable resources models so that they could be more realistically applied to terrestrial species such as the elephant (see Sutton and Jarvis; Schulz and Skonhofs).

Policy considerations also relate to the activities of farmers. For example, if empirical studies indicate that agricultural activities such as livestock raising are more compatible with elephant populations than activities such as maize cultivation, then government could provide incentives for farmers to participate in the lower-conflict activities. If conflict tends to be greatest near sources of water such as rivers, authorities might consider reducing agriculture along rivers or providing water for elephants in less developed areas. If certain deterrents are found to be effective against elephants, government might provide incentives for farmers to use those deterrents (e.g. subsidizing chili bombs). Another possibility would be to establish a crop insurance program for farmers, or to simply pay each farmer in elephant range areas an annual incentive for putting up with the elephants.

Conclusion

The incorporation of the costs of living with elephants into decisions involving the management of elephant populations in African range states is essential for achieving realistic results which maximize the benefits that African nations can derive from their wildlife

populations. This will provide increased incentive for these nations to sustainably conserve their wildlife, including the elephant.

Whatever costs are observed now, it is to be expected that, with rising human and elephant populations, a growing shortage of land and water, increasing investments in infrastructure (e.g. roads, irrigation), and the creation of an improved agricultural marketing system, the agriculturally-related costs of elephants will increase with time. Even if the benefits of elephants increase as well, the need to minimize the agriculturally-related costs will rise. This will place pressure on governments to better understand these costs and to devise better mechanisms to reduce them.

To date, most conservation and data collection efforts have focused on the benefits of elephants, such as the viewing value, the value of trophy hunting, and the value of ivory. However, the considerable costs, both direct and indirect, to the farmers that share their land with the elephants have often been ignored. Efforts should be made to identify and measure these costs as accurately as possible so that they can be included in models of elephant management and be used by decision makers to design optimal elephant management strategies.

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